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SEDIMENTOLOGY, VOLCANOLOGY AND GEODYNAMICS OF THE REDBANK PACKAGE, MCARTHUR BASIN, NORTHERN AUSTRALIA.

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Declaration

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David Rawlings
January, 2002

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David J Rawlings
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Abstract

The ~1815-1705 Ma Redbank package is a 3-6 km thick succession of shallow marine to braided fluvial sandstone and lesser conglomerate, mudstone, carbonates and rhyolitic-basaltic volcanics and high-level intrusions. It forms the base of the Palaeoproterozoic McArthur Basin in northern Australia.

In the southern McArthur Basin, the Tawallah Group is the best exposed stratigraphic component of this package. Coarse-grained facies at the base of the Group formed in a proximal-medial braided fluvial environment and are overlain by widespread sheets of supermature quartzarenite and intervening flood basalt. These enigmatic sandstone sheets contain features consistent with deposition in a complex high-energy shallow marine, fluvial and aeolian setting on an extensive low-gradient shelf. Overlying mudstones and carbonates were deposited on a shallow epeiric shelf and coastal sabkha fringe that onlapped basement tectonic ridges. A regional sequence boundary formed during subsequent regional uplift and local synsedimentary deformation, and was followed by deposition of another widespread quartzarenite sheet. The overlying succession of fine-grained sandstone, mudstone, carbonate and evaporitic redbeds suggest more diverse depositional settings. Marginal marine salina, near-shore peritidal, storm-dominated shelf and moderately deep water settings, with periodic restriction to the marine realm, fluctuating accommodation rates and minor synsedimentary faulting are all recorded.

Regional-scale dolerite sills and an extensive stacked succession of basalt sheets were emplaced sequentially as widely-dispersed invasive flows under a thin blanket of wet unconsolidated sediment and peperite. Volcanism was locally associated with uplift and emplacement of polymict debris flows and breccia bodies. This was followed by deposition of a complex association of clastic sediments and felsic volcanics and intrusion of high-level plutons (upper Tawallah Group). Sheet-like rhyolitic lavas with abrupt talus-lined margins evolved via non-explosive eruption and long-term viscous flow. This was facilitated by low water content and high and continuous eruption temperature and effusion rate. Complex ephemeral alluvial and debris flow aprons formed adjacent to the lavas, recording the generation, erosional denudation and final burial of a dynamic high-relief volcano-tectonic landscape. Epiclastic materials were reworked in bordering lakes and low-relief braidplains that prograded radially away from the volcanic centres. Periods between magmatic events were characterised by deposition of widespread immature sandstone sheets in extensive high-energy ephemeral to perennial braided fluvial settings and the development of low-relief regional disconformities. Concurrent pluton emplacement in the northern McArthur Basin generated a series of structural domes with peripheral deformation. Accommodation space for intrusion was provided by decollement at ductility transitions, upward flexuring, outward gravity slide and vertical displacement of overlying sediments.

Detailed stratigraphic and facies analysis of the Tawallah Group has enabled the development of a tectonostratigraphic framework for the entire Redbank package. Four second order subdivisions are recognised (Yirrumanja, Liverpool, Costello and Mitchell mesopackages) that facilitate a clearer, integrated regional understanding of the lithology, timing and geographic distribution of basin phases. The package concept is also applied to the composite McArthur Basin system as a whole. Five distinct and regionally coherent basin phases are recognised (Redbank, Goyder, Glyde, Favenc and Wilton packages). These were deposited in a dynamic tectonic environment over a period of ~350 m.y.

Geochemical characterisation of Proterozoic igneous phases in northern Australia has confirmed many lithostratigraphic correlations in the McArthur Basin. Felsic units show temporal and spatial variation in geochemistry that reflects partial melting of heterogeneous Archaean mafic lower crust due to the emplacement of large basaltic magma chambers and radiogenic heating. The McArthur Basin contains five main mafic igneous phases with typical flood basalt attributes, spanning a period of ~480 m.y. Magmas were derived by partial melting of chemically-stratified lower lithosphere and do not exhibit a plume or rift signature.

A convergent intracratonic setting is proposed for the Redbank package. Basin architecture reflects diverse subsidence mechanisms operating inboard of the active southern margin of the North Australian Craton (Strangways arc). Wedge-shaped and magmatic-related basin architectures formed during subduction. Subsidence was influenced by dynamic topography, thermally- and mechanically-driven viscoelastic behaviour of heterogeneous crust, magmatic underplating, lithospheric phase transformations, and local transtension and isostatic loading. Local growth-fault architecture formed by incipient back-arc extension. Magmatism was driven by a persistent thermal anomaly related to insulative heating and a transient convective roll emanating from the Strangways arc, that eroded the lower lithosphere and generated a magma pool. Migration of magma into lower-crustal magma chambers and to the surface took place at transtensional sites along lithosphere-scale strike-slip faults. Regional unconformities and elongate and wedge basin architectures formed in the Redbank package during periodic terrane accretion events at the Strangways arc. Subsidence was influenced largely by transmission of in-plane stress through the lithosphere to produce lithosphere-scale folding, viscoelastic deflections of the lithosphere, and transtensional strike-slip and flexural back-bulge basins. Local elongate magmatic grabens are interpreted as impactogens resulting from indentor tectonics.

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